

International Trade, Transportation Networks, and Port Choice

Bruce A. Blonigen

University of Oregon and NBER

Wesley W. Wilson

University of Oregon

Motivation

- Fast-growing international trade volumes present major challenges for ocean ports
 - ▣ Significant investments in facilities required
 - ▣ Larger ships require deeper shipping channels
 - Anecdotal evidence suggests there are big differences in U.S. port investments and efficiency
 - Are port choices significantly affected by such factors or are geographic factors the overriding influence (distance and population density)?
 - Important for shaping public policy on port investment, among other things
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Motivation

- In fact, we know very little about the importance of various factors for port choices
- Previous literature is sparse
 - Surveys of shippers (e.g., Lirn et al., 2003 & Song and Yeo, 2004)
 - Yield different answers across studies
 - Answers may not pertain to the practical importance of a factor on the margin

Motivation

- Previous literature continued
 - Statistical analysis of a targeted set of shipments (e.g., Malchow and Kanifani, 2001 and 2004, & Tiwari et al., 2003)
 - Sample sizes small
 - Malchow and Kanifani (MK): U.S. exports of 4 sets of commodities across 8 ports in December 1999
 - Tiwari et al.: 1000 containerized shipments in China across 14 ports
 - Both find that inland distance matters and MK finds that ocean distance matters as well
 - Both curiously find greater frequency of shipments from a port decreases its likelihood to be chosen for the shippers they sample
 - Only Tiwari et al. examines port attributes and finds mixed evidence for any effects on port choice
 - Neither study can examine effects of changes in transport costs
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Our Approach

- Examine port choices of all U.S. import shipments from 1991-2003
 - Advantages of our approach
 - Will give big picture of port choice determinants
 - Identifying off of not only cross-section, but also time-series changes (e.g., role of transport costs can be examined)
 - New data used from companion paper on port efficiencies
 - U.S. is very interesting country to study because of geographic size and decentralized port operations
 - Disadvantages of our approach
 - Shipment data aggregated, not individual shipments
 - Location of importer unknown
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Empirical models

- Employ two different types of empirical models to estimate determinants of port choice
- Conditional logit framework
 - Costs (C) for shipment between shipper-importer combination (i) through seaport (j) are:

$$C_{ij} = \beta_1 OC_{ij} + \beta_2 IC_{ij} + \beta_3 PC_{ij} + \mu_{ij}$$

where OC_{ij} are ocean transport costs
 IC_{ij} are inland transport costs
 PC_{ij} are port costs, and
 μ_{ij} is an error term

Empirical models

■ Conditional logit framework

- Issue 1: Data aggregate individual shipments between foreign country and importer
 - Use share (proportions) data on port choices, assuming individual choices can be represented theoretically by single exporter allocating across ports
- Issue 2: Don't know ultimate import destination
 - Assume proportional to distant-weighted economic activity:

where $IC_{jt} = ip_t \prod_{k=1}^K id_{jk} GSP_{kt}$,
id is inland distance
ip is price of inland transport
GSP is gross state product (k indexes states)

Empirical models

■ Gravity framework

- Trade between foreign country and U.S. ports a function of distance (i.e., transport costs) and economic activity
- Proxy for importer's size with "market potential" of port

$$MP_{jt} = \alpha \sum_{k=1}^K \frac{1}{ip_t id_{jk}} GSP_{kt} = \frac{1}{ip_t} \alpha \sum_{k=1}^K \frac{1}{id_{jk}} GSP_{kt},$$

- Estimated gravity equation:

$$\ln V_{ijt} = a + g_1 \ln GDP_{it} + g_2 \ln ip_t + g_3 \ln \left(\alpha \sum_{k=1}^K \frac{1}{id_{jk}} GSP_{kt} \right) + g_4 \ln op_t + g_5 \ln od_{ij} + g_6 \ln PC_{jt} + e_{ijt},$$

where V is trade volume (in US \$)

GDP is gross domestic product of foreign port

ε is an error term

Empirical models

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Data

- Import data from National Data Center of U.S. Army Corps of Engineers which is comparable to Census data
- Ocean distance also from U.S. ACE data
- Inland distances calculated as between port and state capitol cities
- U.S. Gross State Product from BEA of Census
- Foreign country GDPs from World Bank
- Inland transport costs are annual railroad freight rates from Association of American Railroads
- Ocean transport costs are annual data on dry cargo freight rates from UNCTAD
- Port efficiency measures from companion paper

Data

- Sample spans import transactions involving 46 U.S. ports, 117 foreign country sources for the years 1991 through 2003
- Top 46 U.S. ports account for over 95% of import volume
- Qualitatively identical estimates when we use volume measured by weight (rather than in dollar values)
- Will examine total import activity, as well as shipments that are 100% containerized

Results

Table 2: Conditional Logit Estimates of Factors Affecting U.S. Port Choice for Imports

	All Imports to Top 46 U.S. Ports	Container Imports to Top 15 U.S. Ports
Ocean Transport Costs	-3.153** (0.109)	-3.237** (0.129)
Inland Transport Costs	-0.038** (0.005)	-0.023** (0.005)
Port Efficiency	1.263** (0.188)	2.438* (1.086)
Observations	95680	27285
Pseudo R-squared	0.09	0.11
Log Likelihood	-7269.74	-4362.11

NOTES: Standard errors in parentheses. * and ** denote statistical significance at 5% and 1% level, respectively.

Result

**Table 3: Estimates of Factors Affecting Import Volumes into U.S. Ports
Using a Gravity-Model Specification**

	Ordinary Least Squares	Fixed Effects	Two-Stage Least Squares
Distance	-2.888** (0.037)	-5.963** (0.070)	-6.002** (0.072)
U.S. Port Market Size	-0.121** (0.036)	-0.094 (0.338)	-0.181 (0.360)
Foreign Market Size	1.811** (0.008)	0.624** (0.182)	0.669** (0.200)
Inland Transport Price	-0.382 (0.475)	-2.978** (0.949)	-3.034** (1.029)
Ocean Transport Price	-0.867** (0.307)	-0.687** (0.230)	-0.675** (0.234)
Port Efficiency	1.352** (0.228)	-0.085 (0.206)	-0.163 (0.894)
Constant	-1.487 (1.781)	53.052** (5.780)	53.928** (6.064)
U.S. Port Fixed Effects	No	Yes	Yes
Foreign Country Fixed Effects	No	Yes	Yes
Observations	74612	74612	68954
R-squared	0.35	0.64	0.64

NOTES: Standard errors in parentheses. * and ** denote statistical significance at 5% and 1% level, respectively.

Result

Table 4: Estimates of Factors Affecting *Containerized* Import Volumes into U.S. Ports Using a Gravity-Model Specification

	Ordinary Least Squares	Fixed Effects	Two-Stage Least Squares
Distance	-2.015** (0.045)	-5.094** (0.078)	-5.174** (0.082)
U.S. Port Market Size	0.356** (0.038)	1.148** (0.356)	0.310 (0.392)
Foreign Market Size	1.395** (0.011)	1.147** (0.222)	1.516** (0.274)
Inland Transport Price	-10.982** (0.549)	-8.157** (0.987)	-14.581** (1.165)
Ocean Transport Price	1.399** (0.361)	-0.388 (0.236)	-1.259** (0.341)
Port Efficiency	-1.539** (0.210)	-0.596** (0.141)	2.123** (0.509)
Constant	-9.252** (2.085)	23.696** (6.172)	37.521** (6.687)
U.S. Port Fixed Effects	No	Yes	Yes
Foreign Country Fixed Effects	No	Yes	Yes
Observations	62805	62805	55431
R-squared	0.20	0.63	0.63

NOTES: Standard errors in parentheses. * and ** denote statistical significance at 5% and 1% level, respectively.

Summary of results

- Much more comprehensive sample to estimate effects of various factors on ocean port choice than previously
- Significant evidence of the effect of distance, ocean and inland freight rates, and port efficiency on port choice
- Gravity specification yields much larger elasticity for inland transport costs than ocean transport costs, conditional logit is vice versa
- Evidence that port efficiency matters significantly, particularly for containerized shipments

Future directions

- Controlling for spatial interdependence in gravity specification
- Examination of heterogeneity in estimates across foreign country sources (e.g., Asia versus EU shipments)
- More examination of heterogeneity in estimates across products